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Neutrino Telescope: News

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ABSTRACT: *A brief review is given of the existing methods and devices currently used for recording astrophysical mostly solar neutrinos. These structures, as a rule, have significant, often cyclopean dimensions, insignificant sensitivity and difficulties in determining the direction to the neutrino source. New types of neutrino telescope are described, which are based on the physical effect of anomalous neutrino radioisotope (ANRI) absorption. One type has a high sensitivity, small dimensions, low cost, but also how all existing ones determine the direction of neutrino arrival through the interaction tracks. The other type of telescope, while maintaining these advantages, points to a neutrino source similarly to an optical one - by the direction of the axis of the design structure not on the neutrino interaction tracks, but on their source. The results of a successful test of the current layout are given.*

KEYWORDS: *astrophysical neutrinos, anomalous neutrino radioisotope (HENRI) absorption, neutrino telescopes based on the ANRI effect.*

I. NEUTRINO TELESCOPE BASED ON THE ANRI ABSORPTION EFFECT.

A few years ago, the authors experimentally finally became convinced of the reality of the existence of the effect of anomalous neutrino radioisotope (ANRI) absorption [1, 2]. Taking into account the applied and fundamental significance of the effect, as well as the need for thorough repetition and verification of the results of primary research, the authors methodically and technically repeated the first successful work, but the registration processes for the ANRI effect were additionally duplicated using a parallel recording channel working on a different principle (the occurrence of a thermal field during decay processes). Both methods: radiometric and thermal, their results coincided with the data of the primary work, as well as among themselves. Thus, the existence of the ANRI effect is absolutely reliably proved [1]. This study actually draws a line under the primary study of the effect of absorption, and is the output of the applied technology of study on a broad front of new exploration, taking into account or based on previous results [2-25]. Indeed, in the initial study, which allowed not only to register the flux of solar neutrinos, but also to record the spectrum of the proper oscillations of the Sun which by the modulated flux of radio emission [1, 2].

Moreover, the actual neutrino detector based on the ANRI effect (see Fig. 2 [1]) by weight of the working radioactive substance did not exceed ~ 10g, which is less than the amount of the substance — specially purified Kamiokande water 1010 times; comparison of registration systems leads to an equally shocking surprise. Therefore, a comparison with the registration system "ICECUBE" in Antarctica is unnecessary. Such striking differences are explained by an increase in the neutrino capture section by a radioactive substance by a factor of 1030 [21]. But the neutrino detector used on the basis of the ANRI effect, as well as all previous ones, is not able to point towards the neutrino source by turning any of its construction side, that is, it is necessary to focus on the source along the neutrino interaction paths with the working substance nuclei. Without the ANRI effect, for example, the Kamiokande system works. Therefore, to create a genuine neutrino telescope capable of indicating the coordinates of the source, the neutrino power, the duration of the impact, it is necessary to combine the ANRI effect and the tracing principle, which is constructively quite realistic (Fig. 2).

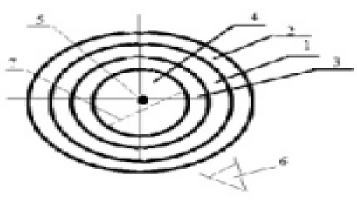

Fig.2a. Autonomous transparent element of the neutrino telescope: 1- liquid transparent spherical layer from a radioisotope (for example, tritium heavy water); 2 - protective external anti-radiation shell of lead-enriched glass;

3-impermeable inner transparent shell; 4- liquid transparent scintillator solution; 5 - transparent point piezo receiver from polarized quartz; 6 - system for recording tracks of interaction of muon and neutrino fluxes with radioisotope 1; 7 - scintillation track.

Figure 2a shows an autonomous separate element of the neutrino telescope, including: a radioisotope element, external and internal bio-protection, phosphor, acoustic sensor and track recording system. It is desirable that all the above listed details be transparent. For increased sensitivity, a separate system is made up of separate units (2a) (Fig.2b). For a transparent bioprotection apply heavy grade glass (25% lead). The radioisotope can be transparent and in liquid form (for example, heavy tritium water). Even the spherical piezoelectric transducer is also optically transparent (acoustic quartz). The selection of such transparent properties of the working elements of the telescope makes it in many ways a device capable of studying the cosmic neutrino much better than previous systems and fabulously cheap. In addition, the telescope is available to work on most transport systems dimensions and weight are quite acceptable. More specifically, you can figure out the class of research problems. Probably, this type of neutrino telescope can be classified according to the ANRI effect, which completely determines the structure of the whole structure. That is, it can be designated as a neutrino telescope with an updated, but old scheme, according to which the direction to the source is determined by the response (for example, optical) of the working substance, and the response does not depend on the orientation of the neutrino source of any characteristic part of the structure. We will abbreviate ANRI neutrino telescope (ANRINT). For efficiency, ANRINT may consist of a set of autonomous elements of the type fig. 2a., Which will significantly increase the signal-to-noise ratio (Fig. 2b). By selecting the characteristics and parameters of the autonomous module (Fig. 2a), the operation of the entire neutrino telescope can be optimized.

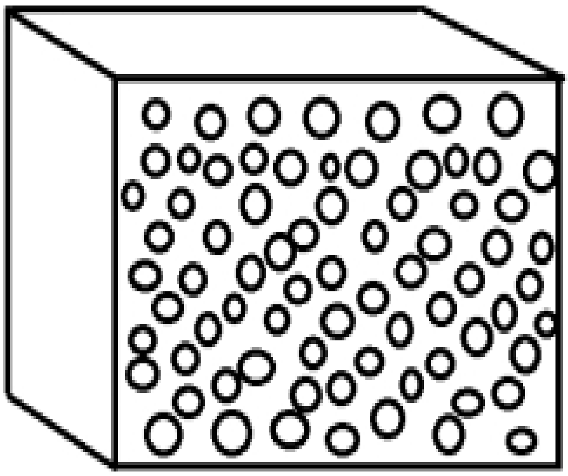

Fig.2b. There is neutrino telescope from a set of individual modules of spherical type (Fig. 2a).

However, there is a need to create a neutrino telescope (NT) literally similar to optical or radio in terms of guidance, when the maximum signal from the neutrino stream corresponds to the direction of the NT axis to the neutrino source, especially considering many other works [25-38]. Such an NT will consist of two blocks: a block providing one of the main telescopic functions — the search and amplification of the useful signal and the block of registration of the primary amplified signal. Both units are operable only on the basis of the ANRI effect. Since the device of the registration unit is sufficiently developed, then the problems of the telescopic unit will be mainly investigated.

II. THERE IS ANRINT WITH AN AXIAL FOCUS ON THE SOURCE (ANRINTFS) OR SIMPLY NTFS.

Unfortunately, the concept of a lens for a neutrino flux is not feasible; therefore, it is necessary to use another method to increase the flux intensity. Consider a series of regular identical disks from a radioisotope, installed along the axis at equal distances (Fig. 3).

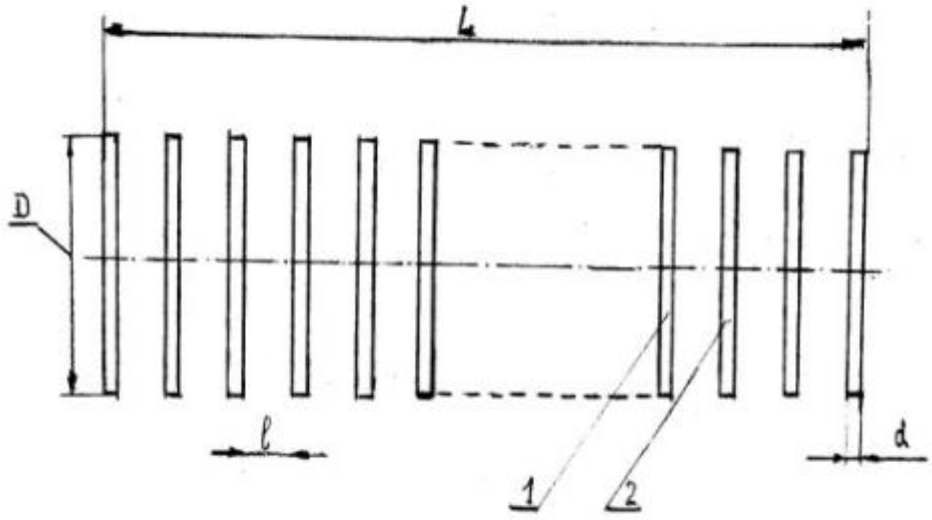

Fig.3. Simplest series of regular disks from radioisotopes, where: L is the total length of the series; d is the disk thickness; l is the distance between the disks; - * - * - centerline; 1, 2 are the disks of the series ∑N, where N is the number of disks. Of interest is the total shape of the neutrino emission diagram by a series of disks (Fig. 3) depending on the distance between the disks,

when basically each disk radiates the same form as the other neutrino flux (antineutrino), see the general picture - Fig. 4.

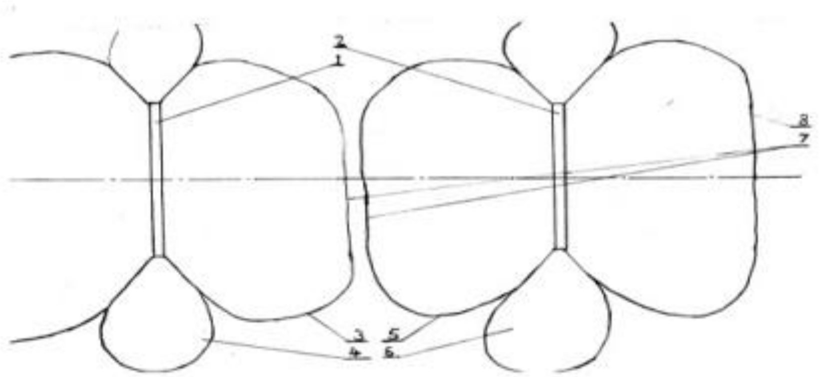

Fig.4. Diagrams of radiation of the neutrino flux by regular round disks of radioactive materials: 1,2- radioactive disks; 3,5- diagrams of neutrino flux emission by the inner surfaces of disks 1,2; 4,6- diagrams of neutrino flux emission from the edges of disks 1,2; 7, 8 - external end surfaces of radiation diagrams of disks 1,2, forming the central, linear zone of the total radiation pattern of the total neutrino flux of a number of disks (Fig. 3) with a total length L. It is obvious that, in accordance with the properties of neutrinos (antineutrinos), the interaction processes of fluxes from individual disks affect both the emission of muons by each disk, and hence the neutrino, and the formation of the level of neutrinos of the surfaces of a series of disks, especially the extreme ones . That is, it is possible that the very stimulating interaction of a series of disks, which has some analogy with an optical quantum generator. In the case of the existence of such a feature, the selection of parameters of a number and characteristics of a radioactive substance will probably allow obtaining from the disk a constantly operating linear neutrino source (LNS), which does not require special equipment and observation, depending on the half-life of a radioisotope with an exceptionally long working time (radiation). Such a scheme in the future is very promising, since it can work on disks with highly active nuclear waste. However, first of all, we will consider the operation of a number of disks, shown in Figure 5, in the ANRITFS mode.

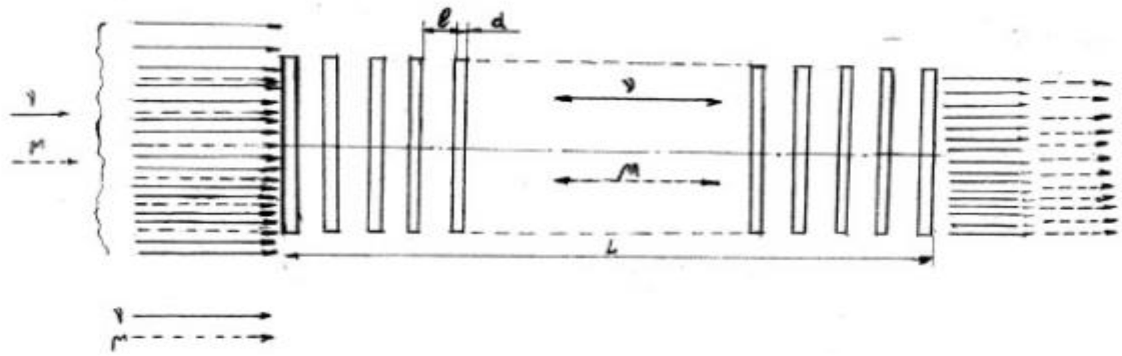

Fig.5. Linear neutrino source in the neutrino telescope mode: γ, μ - denotes neutrino and muon fluxes; ˡ is the distance between the inner planes of adjacent disks; d is the disk thickness; the arrows indicate the neutrino (solid) and muon fluxes (dotted lines); L is the length of a row of disks. Since the fluxes γ, μ from natural sources multiply exceed the internal ones arising from the interaction of the disks, a more intensive interaction of the radioactive substance of the disks with external streams will occur, which will be enhanced by the interaction with the disks. These interaction processes are primarily determined by the angle of orientation of the axis of the linear neutrino source to the natural source. Such is the simplest amplification mechanism in the ANRITFS telescope of the neutrino signal (stream) from an external source. Let us consider the possibilities of increasing the efficiency of this gain, which are also connected with the zones of radioactive disks (Fig. 6).

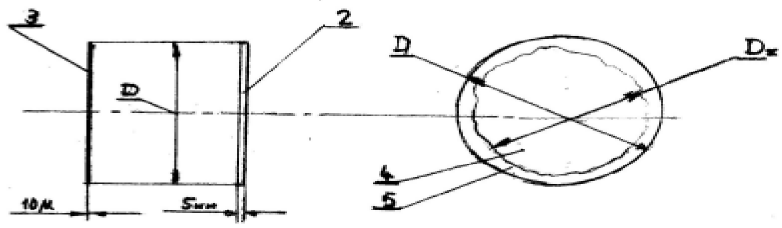

Fig.6. An example of the disk structure by their emission zones γ, μ streams: 2 - a disk as an element of the neutrino source (LIN); 3 - the outer surface of the adjacent disk; 4 - the central zone of the disk, the radiation of which is mainly axial direction; 5 - edge zone of the disk, with a scattered radiation flux; D is the outer diameter of the disk; Dx is the diameter of the disk's radiation zone with predominantly axial radiation. Figures in fig. refer to the experimental sample. According to fig. 6 and in accordance with the laws of radiation of the edge zone of a flat surface, the peripheral zones of the disks do not play a noticeable role in the formation and enhancement of the radiation flux γ, μ from an external source. Therefore, to improve the ANRITFS telescope, it is necessary to exclude the role of the peripheral zone (Fig. 7).

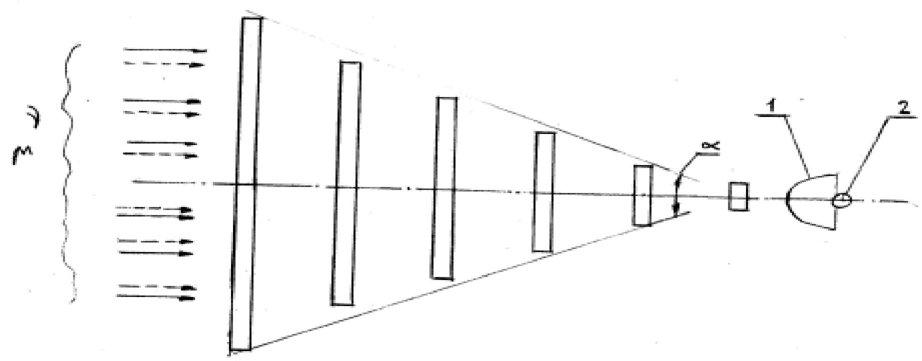

Fig.7. Diagram of the ANRITFS telescope with more efficient use of disks: γ, μ - flow from external sources; α is the linear decrease angle of the diameters of the subsequent disks in order from external to last; 1-radioactive parabolic shell to receive an axial flow of particles from the last disk; 2- shell focus with radiometer or thermometer. As follows from the scheme in Fig. 7, the particle flux from the external disk, significant in area,

takes an axial direction in the disk system and is enhanced by interaction with the disks. In this case, the linearization scheme of the flow direction and reduction of losses due to its dispersion by the peripheral zone of the disks can be improved with further increase in the activity of the radioisotope material of the disks (Fig. 8). For a rough estimate, the degree of amplification is estimated by the ratio of the areas of the plates external to the last.

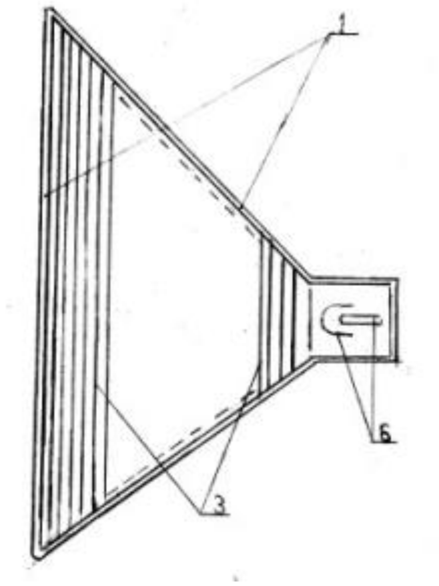

Fig.8. Compact sensitive ANRITFS: 1 - durable sealed enclosure - radioactive screen; 3 - metal disks from a highly active isotope (for example, U-235); 6- registration block. The most advanced version of ANRITFS is durable, hermetic and compact; most suitable for use in mobile systems. The above qualitative representations of different types of telescopes allowed us to proceed to practical research.

III. TESTING OF THE CURRENT LAYOUT OF THE SIMPLEST SCHEME ANRITFS

The simplest mock-up of the ANRITFS telescope or simply NT with the structure in accordance with Fig. 3 was tested, where: L -150mm; d-6mm; D -45mm; l - 15 mm; $\sum N$ - 10. The radioactive cesium isotope was used in the registrar unit; the useful signal was recorded using a thermal sensor. The main task of the test was to determine the reaction of the NT model with its axial orientation towards the Sun or calibration with the solar flux of neutrinos. The maximum of the radiation pattern coincides with the geometric axis of the series. The first tests led to encouraging results (Fig. 9).

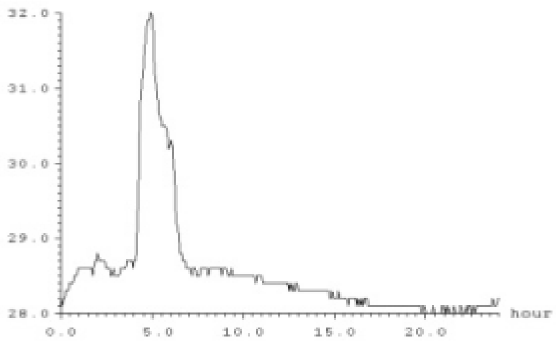

Fig.9. Level of the signal from the telescope layout when passing its radiation pattern over the solar disk.

The model itself consisted of 2 parts: the telescopic unit (TU) itself (diagram in Fig. 3) and the recorder (BR) of the neutrino flux at the outlet of the telescopic unit. The telescopic unit consisted of a set of 10 plastic discs filled with radioactive thorium ore, and located along with an interval of 15 mm. on a wooden rod directed toward the Sun. The recorder was designed as a neutrino temperature sensor based on Baikal uranium ore. It located behind the TU - a set of discs with thorium ore.

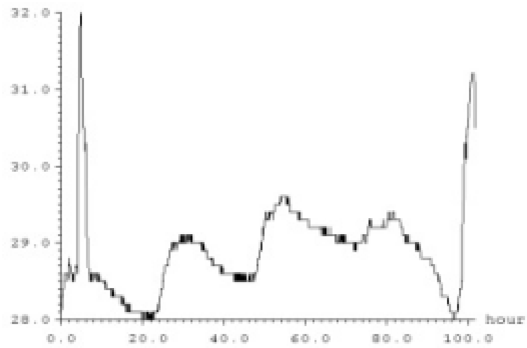

Fig.10. Observations on the neutrino telescope for 4 days

Fig.10 shows the result of both the telescope aperture passing through the solar disk (at the beginning of Fig.9) and the effect of thorium tablets located across at the end of the observation (after 100 hours the telescope was rotated 90 degrees, that is, the disks were directed by ribs in the direction from The sun). From consideration of Figure 9, it follows that the temperature change of 3 degrees Celsius (from 29 to 32) occurred in about three hours, which corresponded to the time of NT aperture passing through the solar disk, taking into account the nature of ore heating. In Fig.10, thorium tablets were located across the sensor at the end of the figure 4 days after the first experiment. Figure 10 also clearly shows the usual daily fluctuations (day-night) of the temperature in the laboratory. Further observations on NTs were carried out using a temperature unit — a recorder on the Cz 137 isotope and the former telescopic unit (Fig. 11). Variations in the sensor temperature from 27 ° C to 30 ° C degrees Celsius with background variations in the laboratory of 0.1 ° C were detected.

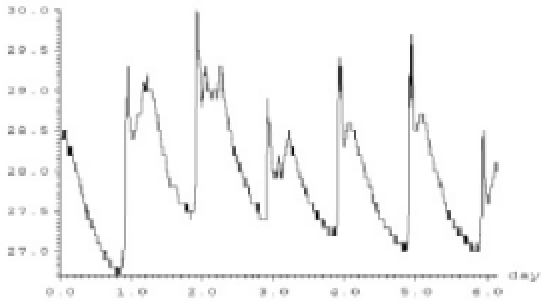

Fig.11. Fragment of the recording of the neutrino telescope during the week.

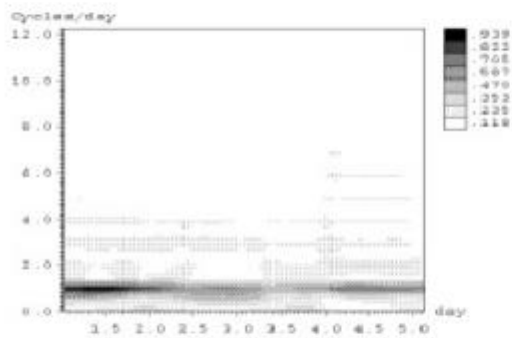

Fig.12. Results of the spectral-temporal analysis of the recording Fig.11. In fig.12 the diurnal component and its higher harmonics are highlighted. Next, the second and sixth diurnal peaks in Figure 11 were identified and a correlation was made between them (Figure 13).

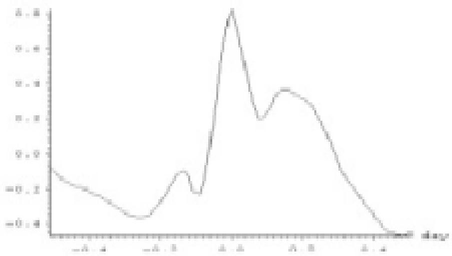

Fig.13.Correlation coefficient between the 2nd and 6th peaks is about 0.8.

Then, a sliding correlation is determined between the whole implementation of Fig.11 and the selected daily peaks in a 10% window (Fig.14, 15).

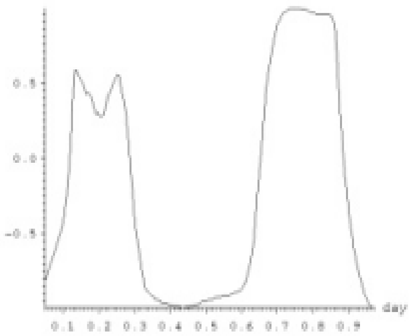

Fig.14.These is correlation coefficient between the 2 -nd peak and the whole implementation.

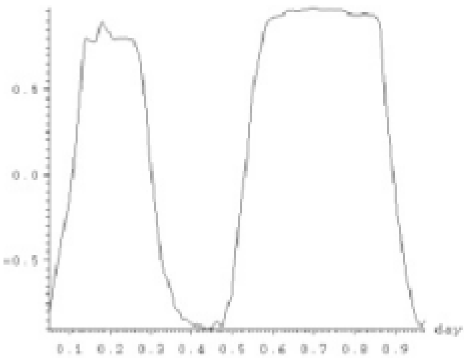

Fig.15. There is correlation coefficient K between the 6th peak and the whole implementation; along the axis of the K value. The abscissa is the current time (days).

The strong similarity of Fig.14.15 confirms the physical reality of the work of NT.

IV. CONCLUSION

1. Opened in 2013 the effect of anomalous neutrino radioisotope absorption (ANRI effect) allowed the simplest, inexpensive, and small-sized installations to ensure the continuous recording of solar oscillations in a modulated solar neutrino flux. 2. A simple method has been developed for creating a sensitive neutrino telescope (NT) based on ANRI - an effect that can not only continuously record the solar neutrino flux, but also along tracks - the direction of the neutrino approach from the source. Compared with the existing neutrino detection facilities, such an NT is many orders of magnitude more sensitive, simpler, easier, cheaper, and more accessible. 3. On the basis of the ANRI - effect, a working model of NT has been created and tested according to the principles of operation similar to the optical one. That is, it determines the direction to the source and amplifies the selected received neutrino signal. Structurally simple and can serve as a model for further development.

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